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EFFECT OF PESTICIDES ON APPLICATION EQUIPMENT

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The problems of corrosion and abrasion occurring in pesticide application equipment have existed since pesticides were first applied. With the recent introduction of many new pesticides coupled with the demand for greater versatility in equipment, these problems have become progressively more serious. In an effort to combat this situation, a research study has been conducted cooperatively for five years with both pesticide and application equipment manufacturers and the U. S. D. A.

PROBLEM AREAS

A review of the information gathered during a survey of equipment manufacturers and users has shown that the sprayer tank is the component most seriously affected by corrosion. In descending order of importance are the hose, pump, nozzle, boom, valve, screen, and dusting equipment components.

SPRAY TANK CORROSION

Although the sprayer tank is the most common source of complaints, this does not necessarily mean loss of tank during a spray season. Steel tanks ordinarily last for 10 years or longer but the accumulation of rust and scale which sloughs off creates abrasion and nozzle plugging problems. This condition causes the most trouble with low gallonage type sprayers using small orifice nozzles and fine screens. There have been cases, however, of steel tanks being penetrated within four years when used solely for applying ammonium sulfamate brush killer. It is also known that if a sodium TCA solution without corrosion retarder should be used in an aluminum tank, its life expectancy may be as short as two or three weeks. These are extreme conditions. In other cases, certain pesticides are less corrosive than tap water and may even act as corrosion inhibitors.

There are several factors which may contribute to the many complaints received concerning the sprayer tank. Perhaps the most important is the lack of care and maintenance of equipment by the operator. Another factor may be faulty design which in some cases has made it impossible or extremely difficult for the user to clean his tank thoroughly due to lack of adequate openings. Although mild steel is the most common material used in tank construction for reasons of economy and design, it is quite subject to rusting in the presence of moisture whether pesticides are present or not. Of course, in many cases the pesticide itself may have a very corrosive effect, either immediate or upon breakdown of the chemical after long periods of residence in the tank. Pesticide manufacturers have in many cases attempted to slow these reactions through addition of corrosion inhibitors or stabilizers to prevent chemical breakdown. The inhibition of sodium TCA by the addition of sodium dichromate is a notable example.

EFFECT OF SOLVENTS

In the past, many equipment manufacturers have applied organic coatings for protection of the tank interiors. These were either general purpose paints, enamels, or lacquers and they withstood the action of the few solutions or suspension materials such as bordeaux mixture or lime-sulfur which were used at that time. Since the introduction of the emulsifiable oil concentrates of such pesticides as DDT, chlordane, and 2,4-D esters, most organic coatings, with certain exceptions, are destroyed by solvents used in the new formulations. Clogging of screens and nozzles by loosened coating particles increased the nuisance problem still more. Progress in solving these tank problems is discussed later.

As with interior tank linings, the problem of rubber hose, gasket, and diaphram deterioration became quite serious after the introduction of the emulsion type formulations. Aromatic solvents such as Xylene or Toluene are commonly used in these formulations. They are very destructive to natural rubber and some of the synthetic rubber materials such as the GRS type which had been in general use. Equipment operators reported swelling, blistering, or softening of these rubber components which necessitated frequent replacement. Equipment manufacturers have now substantially minimized the hose problem through use of synthetic rubber compounds with greater resistance such as Buna N or Thiokol for a tube liner and Buna N or neoprene for a cover. Other synthetic plastics such as Teflon are being incorporated into packing and gasket materials for special application with good success. Research is presently being continued toward finding other suitable synthetics for gasket and diaphram use.

ABRASION PROBLEM

The third component requiring continued study is the sprayer pump. This is the heart of every sprayer. Some of the problems arising here have been due to both corrosion and abrasion. In general, abrasion has been caused by the diluents used in wettable powder. Diluents are necessary in these formulations as they are used as grinding aids and adsorbents for the toxicant. Other sources of abrasion have been traced to the use of water containing sand or other foreign matter which the operator has taken from a stream to make up his spray solution. Some of the newer pesticides have been reported as being extremely corrosive, however, and have attacked pump parts not previously affected. Porcelain cylinder wall linings and stainless steel pistons have been attacked causing damage to plunger cups and packings and subsequent loss of pressure. More new wettable powder formulations together with the increasing trend toward higher concentration of these suspended materials are creating more difficult problems for all pumps. Although pumps of the gear or roller type have become very popular for tractor-mounted sprayers due to their compact size and high capacity, they should not generally be recommended for handling suspension materials. A majority of these pumps have very low abrasion resistance. Centrifugal pumps are also affected by abrasion although to a lesser extent than the other rotary types. Ball valves, seats, and valve cages of piston pumps have also been subject to severe abrasion when wettable powder sprays were used under high pressure. Finding suitable plunger cup and packing material for these pumps creates the complex problem of resistance to both abrasion and solvent destruction. Diaphram type pumps have demonstrated very good abrasion resistance to wettable powder materials but resistance of presently used diaphram material to spray formulation containing solvents is relatively poor. To meet these pump problems, the equipment manufacturers have

laboratory and field tested a great variety of new construction materials. Some of these have shown good promise and are finding their way into the new models. Typical examples are the use of new ceramic materials for cylinder walls, chromium-cobalt-tungsten alloys for valves and valve seats, and nickel-copper-chromium-iron alloys for rotary pump castings. Plastics such as Teflon and Nylon show promise for use in packings and valve construction.

Problems encountered with spraying nozzles can be attributed mainly to abrasion or erosion although in some cases corrosion is undoubtedly a factor. Again the main source of trouble is due to the use of wettable powder sprays or dirty water. Of the three types of nozzles: solid cone, hollow cone, and flat spray, the latter appears to be the most susceptable to erosion. This type usually depends on a knife-edged and elongated orifice for its flat fan spray and uniform coverage. The original orifice size and shape of all nozzles must be maintained to prevent increased flow through the nozzle which otherwise would result in overdosage and uneven coverage. Enlarged orifices would also cause a pressure drop when the nozzle output reaches the capacity of the pump. Recently materials such as hardened stainless steel, ceramics, and tungston carbide have come into the field of nozzle construction and have shown increased abrasion resistance.

DUSTER PROBLEMS

In general, problems encountered with the use of pesticides in dusting equipment have been found to be less severe than those occurring in spraying equipment. Unless there is considerable moisture present, corrosion will not be serious. However, operators must be cautioned against leaving pesticide materials in the equipment when it is not in use. In many instances, abrasion has been reported as being the most important problem affecting dusters. There is a wide range in the relative abrasiveness of the many types of diluents. Involved are such variables as particle size, inherent hardness of the basic material, and amount of still harder materials that may be present as impurities. To reduce both corrosion and erosion in the fan and fan case, stainless steel is being used in certain instances. Rubber or rubber-lined steel distribution tubes are also greatly reducing the amount of wear usually occurring in these components.

EVALUATION OF TANK COATINGS

Since corrosion in the sprayer tank, together with its secondary effects on the other sprayer components, has been considered to be the most important problem confronting all concerned, the research investigation has been concentrated toward this end. Two main lines of approach to this problem have been taken under consideration: (1) Investigation of internal protective coatings for steel tanks, and (2) Investigations of better tank construction materials including metal alloys and synthetic materials.

Because of the complexity of the tank problem, most manufacturers of coating materials were not prepared to suggest or offer suitable products. It was necessary to initiate laboratory evaluation tests followed by preliminary field tests to obtain the desired information. Although there are tests still underway at the present time by various groups, a fairly clear picture of the comparative resistance of coating types is now apparent. The heat curing phenolic and epoxy resin type coatings have shown the best resistance to both pesticides and solvents. Room temperature cure

type phenolic, furan, and epoxy resin coatings have shown acceptable resistance to many pesticides but their solvent resistance is generally lower than the heat cure type. Asphalt or coal tar, neoprene, vinyl, and any of the common machinery coatings have low solvent resistance and should not be employed where emulsion type pesticide formulations are to be used. Although ceramic or porcelain type coatings offer very good chemical and solvent resistance, they are subject to cracking and flaking due to mechanical damage, thus leaving the base metal exposed.

Correct application procedures for coatings of any type cannot be stressed too much. No matter how chemically resistant a coating may be, its protection of the base metal is no better than its bond to the metal. The application of tank coatings should only be performed by specialists as the work involves special tank cleaning and metal preparation procedures plus baking equipment if the coating requires it. A sprayer tank that has been properly coated should be given good care. Periodic cleaning, inspection and coating repair will increase the service life of a tank and reduce the nuisance problem of strainer and nozzle clogging.

EVALUATION OF METALS

In the past, various laboratory studies have been undertaken by several groups to learn something of the corrosive properties of pesticides in the presence of common equipment construction materials. Laboratory testing, however, can only serve as a possible indication of field experience as it would be very difficult to discover and reproduce the exact service conditions. Some of the influencing variables would include the source of water used to make up the solution, the presence of more than one pesticide, electrochemical action between different metals, amount of sprayer use, and the care given in cleaning the equipment.

Although the knowledge of a particular pesticide's corrosive nature would be of interest, it was felt that a corrosion test program for determining the relative resistance of metals to a wide variety of pesticides and actual operating conditions would be of greater importance. A program such as this has been underway for three years utilizing specimens of metallic alloys suspended in many types of operating sprayers. Although the data obtained was developed under conditions existing in sprayer tanks, it has been possible to translate this data directly for certain other components of the spray system. In other cases, it has only served as a possible indication of experience.

The results of this evaluation program have shown that out of the many metals tested, only the 18-8 grades of stainless steel offer almost complete resistance to pesticide chemicals. Mild steel and other low alloy steels are attacked by such a large number of chemicals, that they can only be justified for short time use. The rust and scale formed would soon cause clogged screens and nozzles. Copper and brass, although not producing harmful corrosion products, are also attacked by many chemicals although not always visible to the eye. These alloys do not appear to be particularly good where dimensions are critical. Aluminum, like the copper alloys, generally suffers an even attack by many chemicals but it is also susceptable to deep pitting or perforation in the case of a tank. Zinc has generally shown a reasonably high corrosion rate, in view of the thickness that it would be used on galvanized steel sheet. On the average, galvanized sheet would lose its zinc coating in two years or less. Bronze alloys and Ni-Resist (a cast iron containing a small amount of nickel) show reasonably good corrosion resistance and their use is definitely warranted over the use of common cast iron which has a lower degree of resistance.

PLASTIC TANKS

Due to the rapid growth of the field of plastics, there has been considerable interest recently in their possible use as a sprayer tank construction material. Investigations have been undertaken on the group commonly termed reinforced plastics such as the polyester or epoxy resin and fiber glass combinations. Laboratory and field tests have shown these materials to have remarkable strength and complete resistance to a wide variety of pesticides and solvents. Because of these properties plus the fact that the cost of a reinforced plastic tank is approaching that of aluminum, their future looks very promising.

The resistance of polyethylene to both chemical and solvent attack has proven acceptable for many pesticides. Because of its cheapness and flexibility, its use is meeting with good success as a liner for steel drums commonly found on weed sprayers.

EFFECT OF NITROGEN SOLUTIONS

As it is realized that pesticide application equipment may be used for handling the recently introduced nitrogen fertilizer solutions, the corrosion resistance of sprayer construction materials to these solutions has been included in the research investigation. The solutions concerned are of the non-pressure type and consist of varying amounts of free ammonia, ammonium nitrate, and urea, all in water solutions. Results of recent tests with metals have shown only certain grades of stainless steel and aluminum to have complete resistance to these chemicals. Mild steel and the low alloy steels are subject to rapid pitting. In addition to the danger of tank perforation, rust product contamination of the fertilizer solution could be expected to result in pump and nozzle erosion and clogging. Due to very rapid corrosion attack, the following alloys should be avoided where possible: Monel, zinc, cast iron, Ni-Resist, copper and copper base alloys.

Laboratory and field tests of reinforced plastics, such as fiber-glass reinforced polyester resins, have shown these materials to be completely resistant to the effect of nitrogen solutions. Tanks constructed of these materials are now commercially available for fertilizer equipment. Rubber and polyethylene-lined steel tanks are also being used with good success.

BIBLIOGRAPHY OF LITERATURE

A list of the literature dealing with the effect of pesticides on application equipment was prepared as a part of this research study. It was reported with the annual progress report No. 5 which is technical in nature. Short abstracts of each article were included covering the period from the earliest investigation to the present.